



# Cassini-Huygens Gas Chromatograph Mass Spectrometer: First Results

Interplanetary Probe Workshop #3  
Athens, Greece

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# The GCMS Team

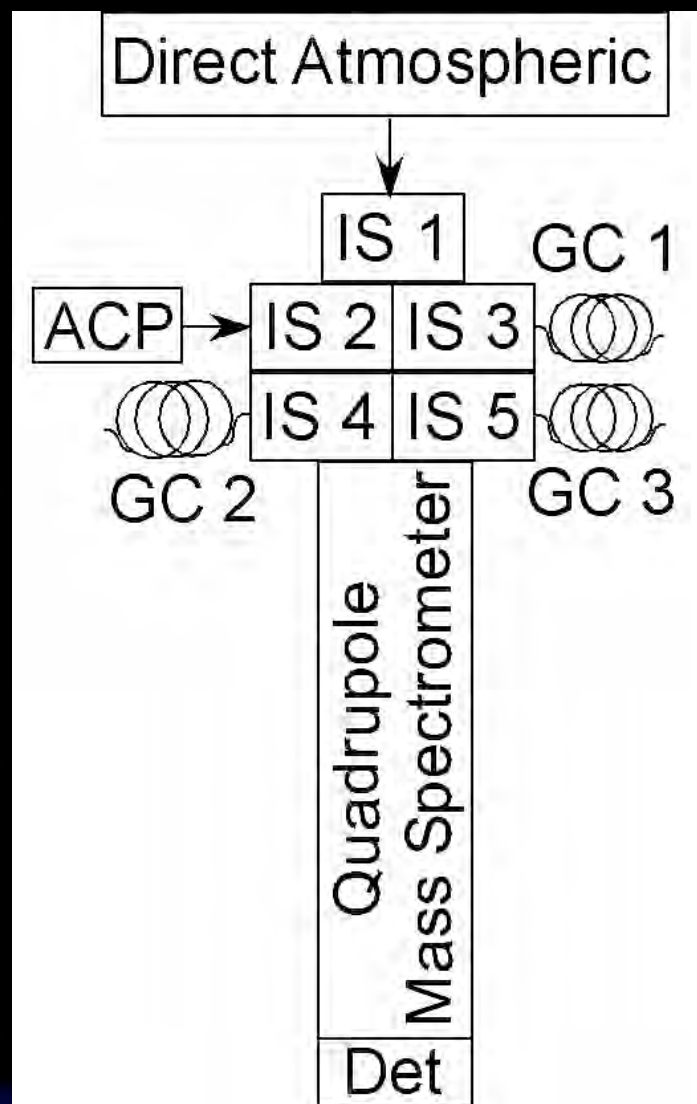
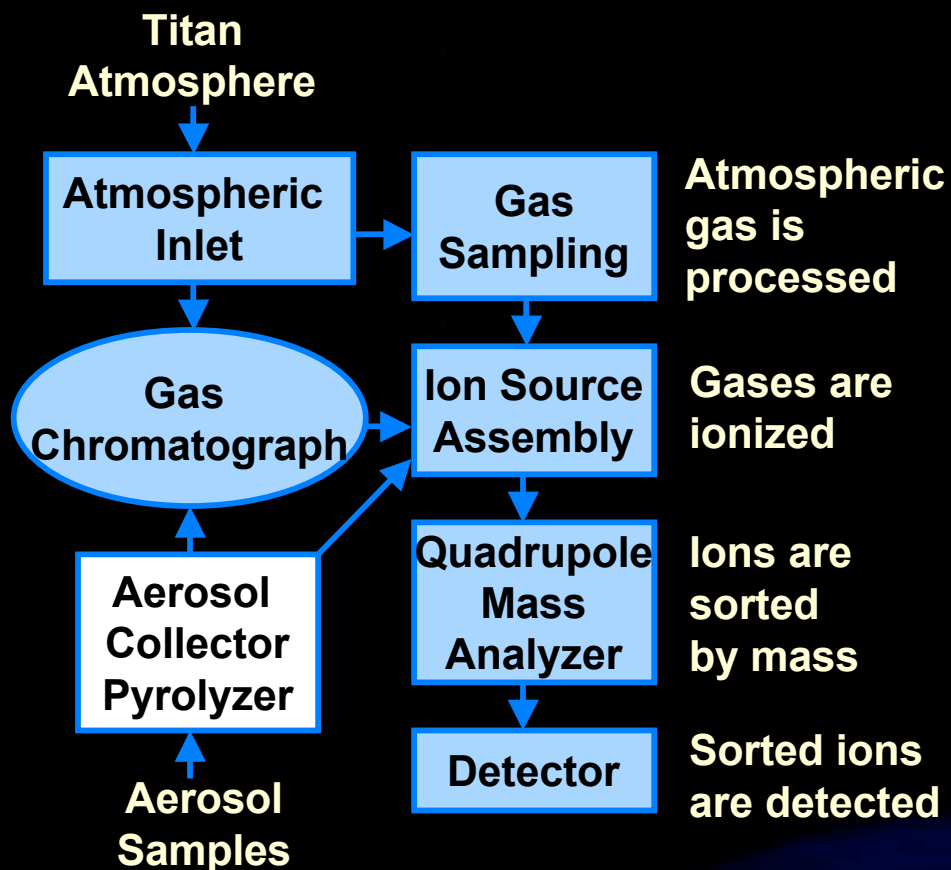
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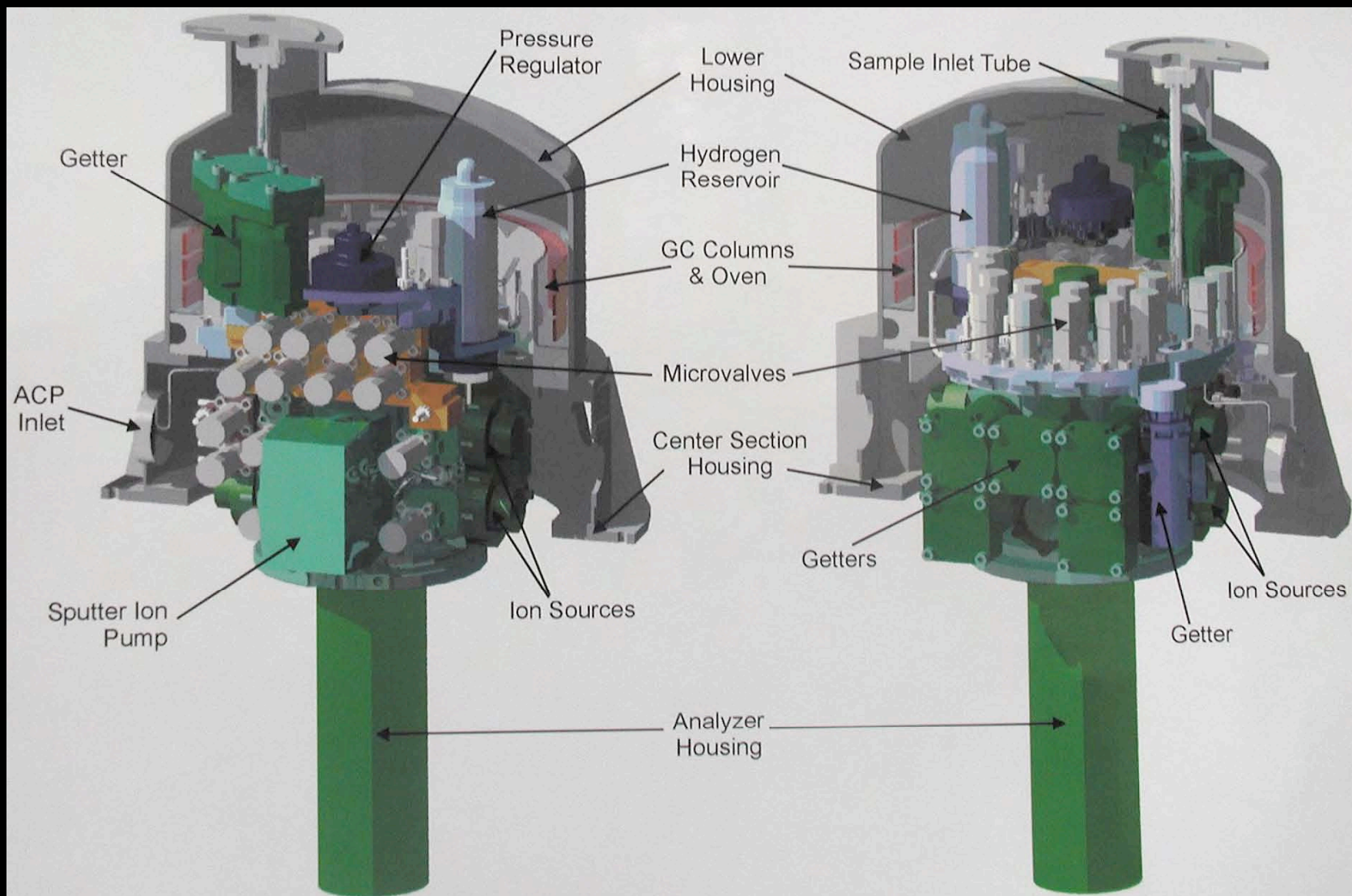


# Operating Principle





# GCMS Internal Design







# Flight Configuration



Exhaust  
Tube

Pressurized  
Housing

Mounting  
Flange

Outlet  
Break off

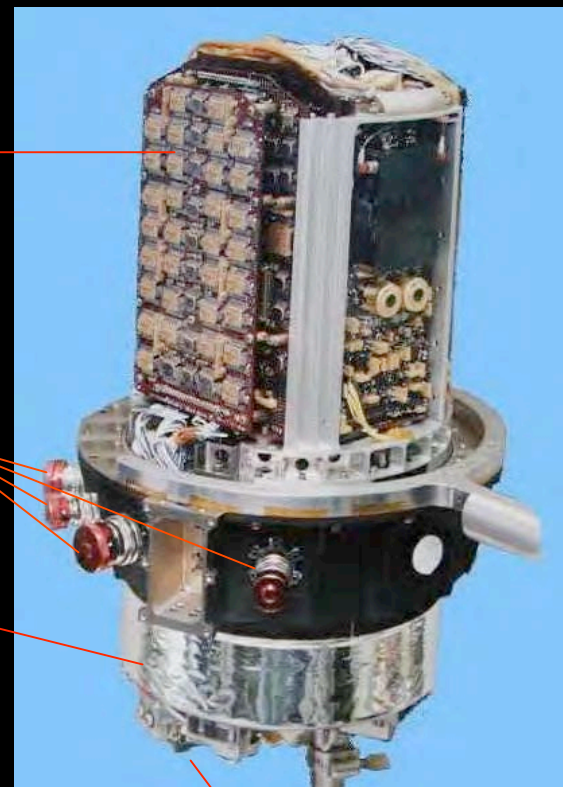
Thermal  
Inlet Isolator

Inlet  
Break off

Prom Board

Electrical  
Connectors

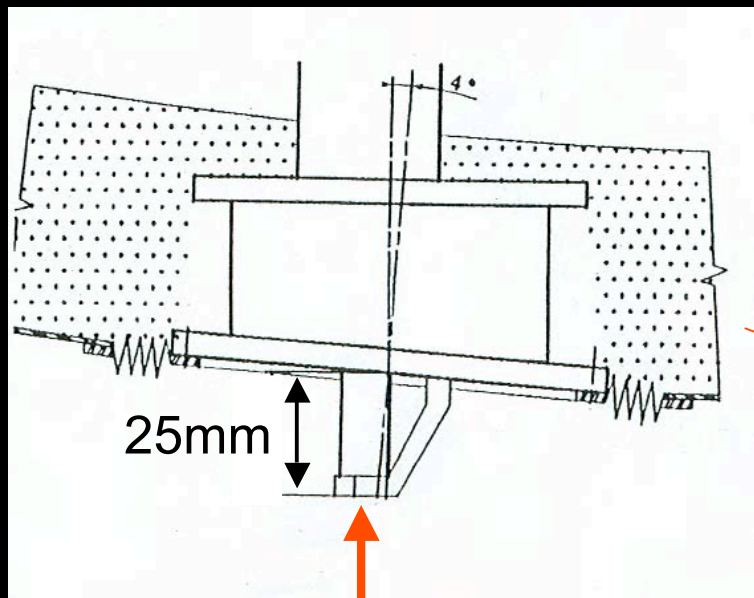
GC  
Columns



Ion Pump  
HV Supplies

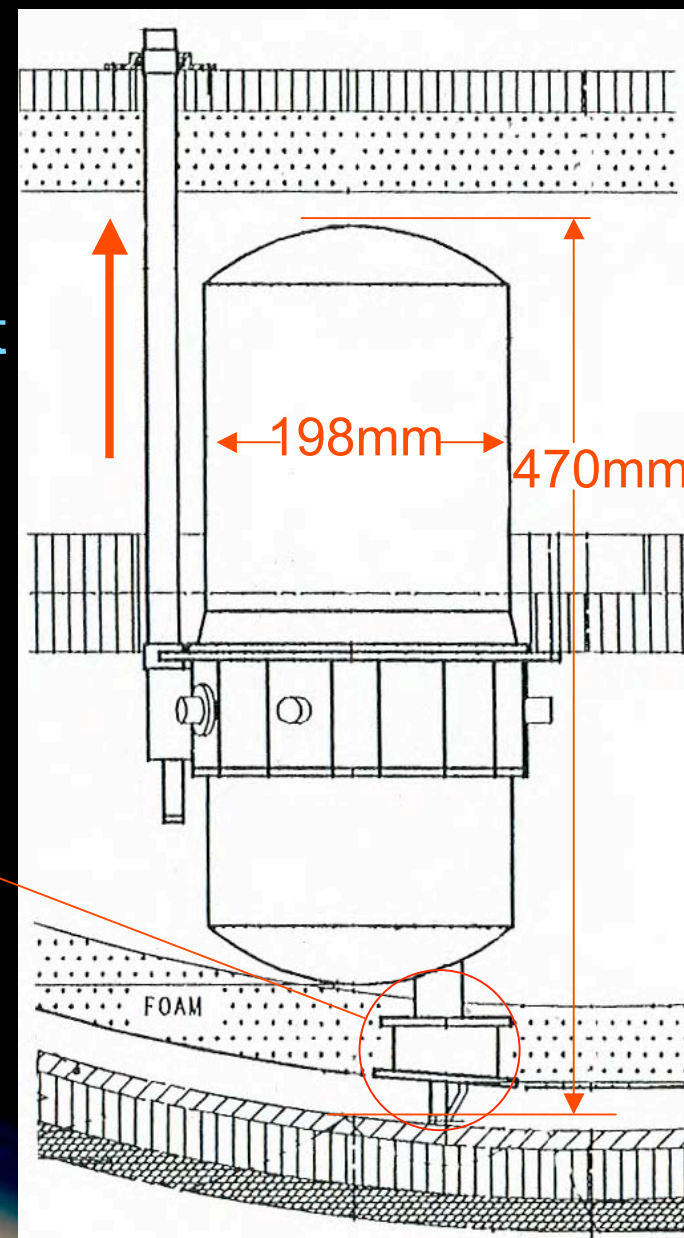


# Heated Sample Inlet



Atmospheric  
Inlet

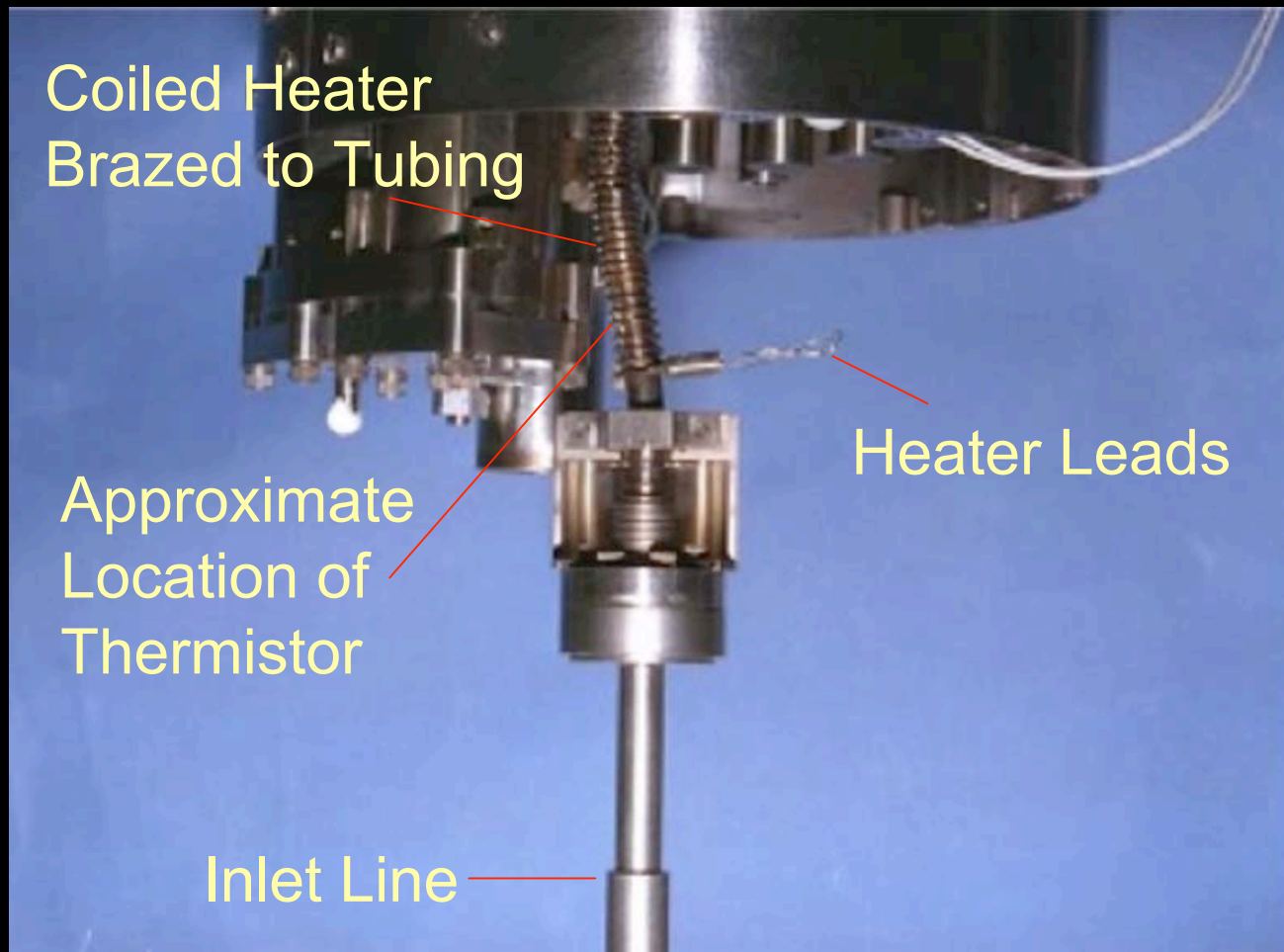
Exhaust  
Outlet



Front  
Shield

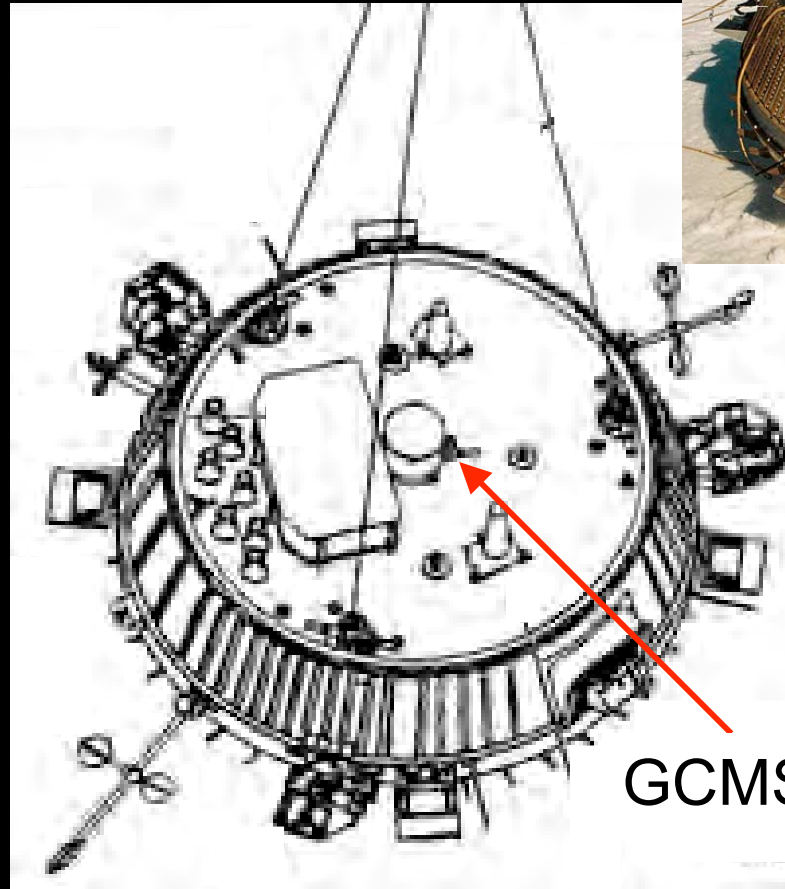


# Inlet Thermistor

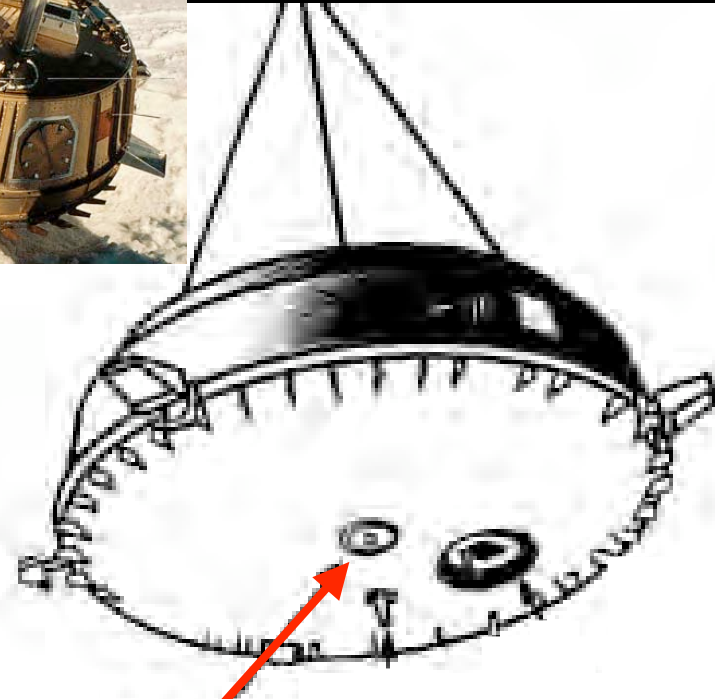




# Inlet and Outlet Locations



GCMS Outlet

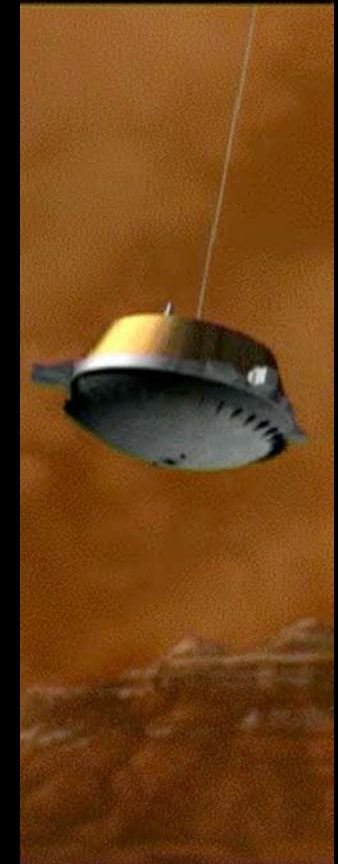
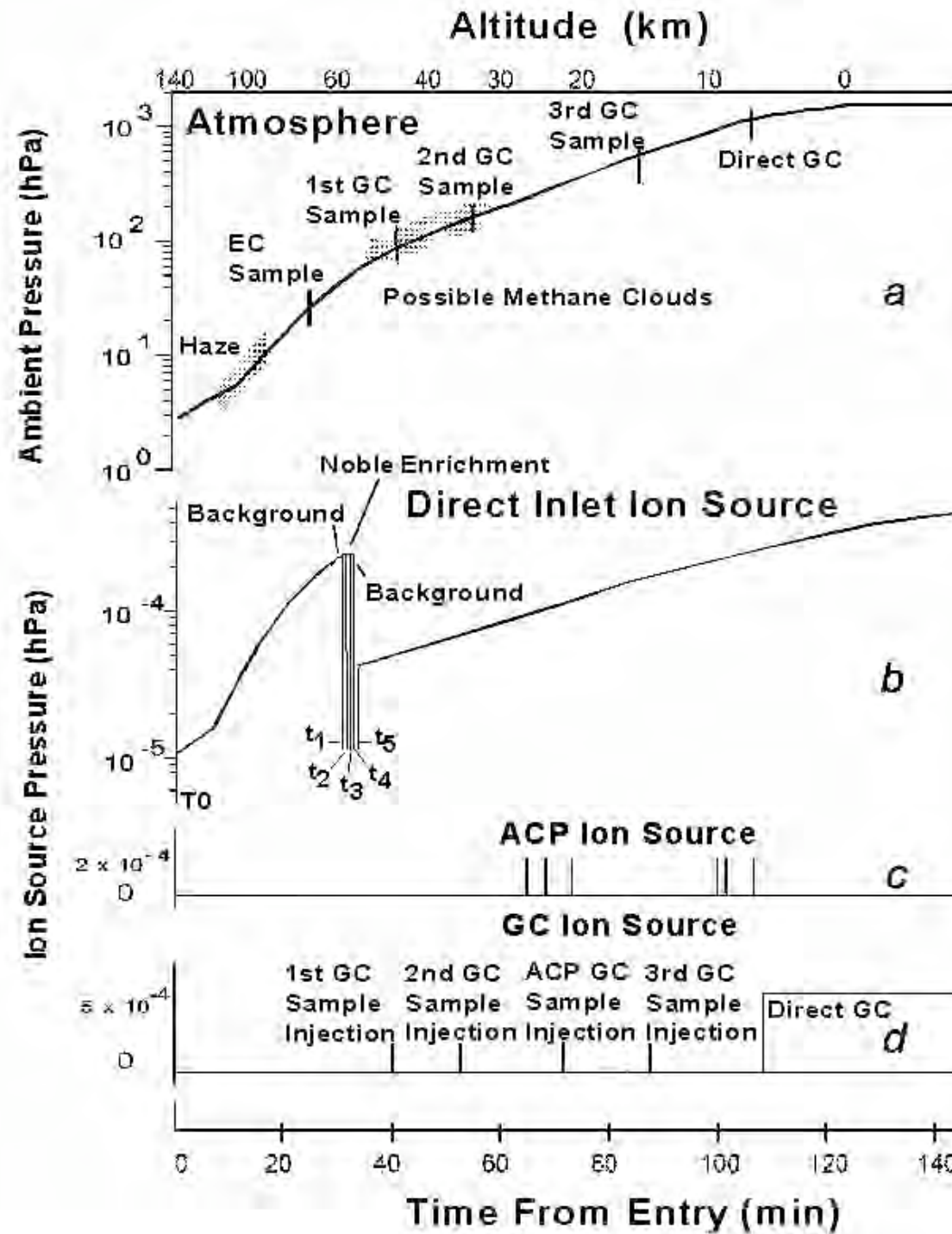


GCMS Inlet





# Descent Sequence





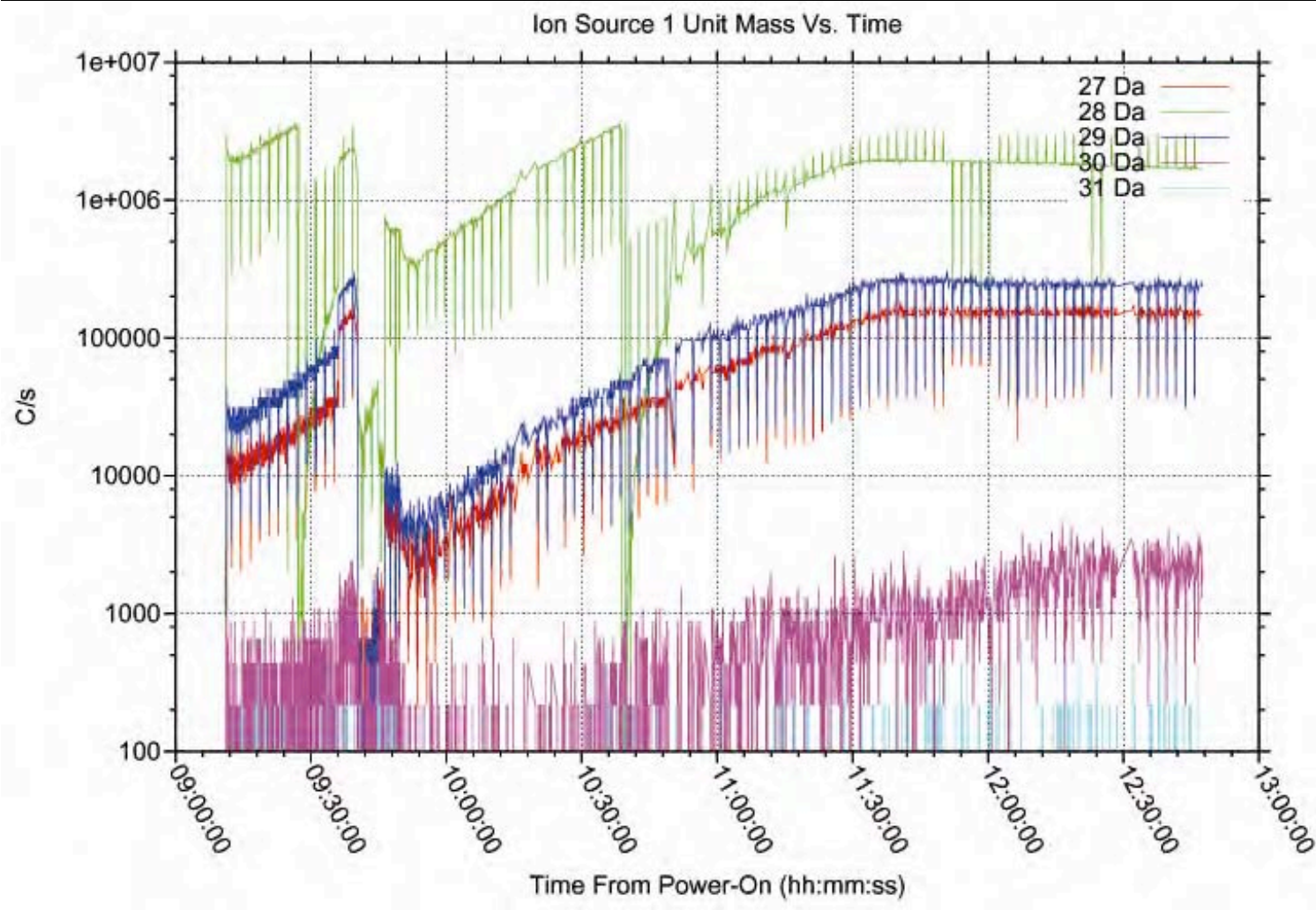
# Instrument Performance

- The instrument executed the pre-programmed sequence as expected
- Data were taken from about 146 km altitude to the surface
- 2h27m descent operation yielding 5634 mass spectra
- 1h10m surface operation yielding 2692 mass spectra
- Ion source 5 failed to operate early in the descent
  - Loss of data from one gas chromatograph column which resolved CO and N<sub>2</sub>
- Loss of channel A effected time resolution and signal statistics, no loss of essential data



# Early Data Analysis

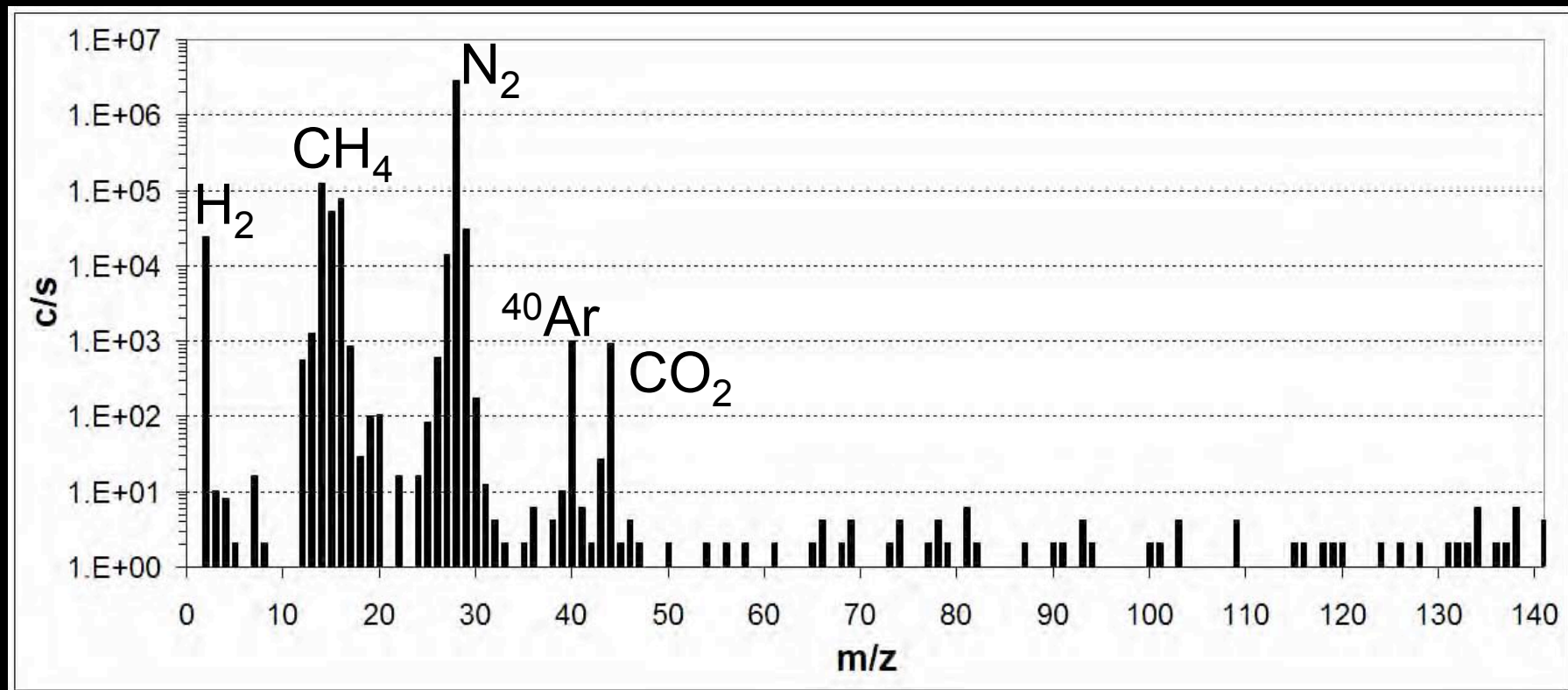
- Data included both 25 eV and 70 eV electron energies, as well as data that both overflowed bit counters and rolled over the detector







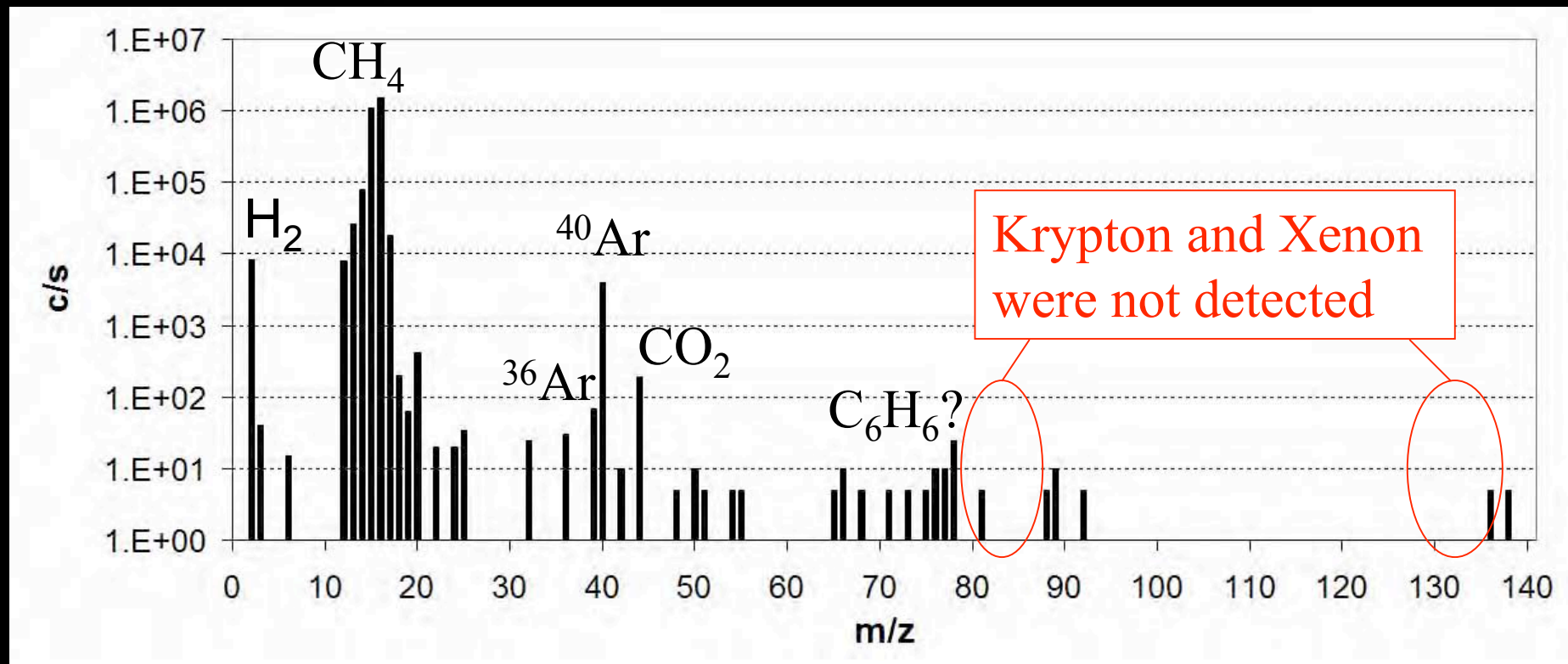
# Upper Atmosphere Averaged Spectrum (130-120 km)





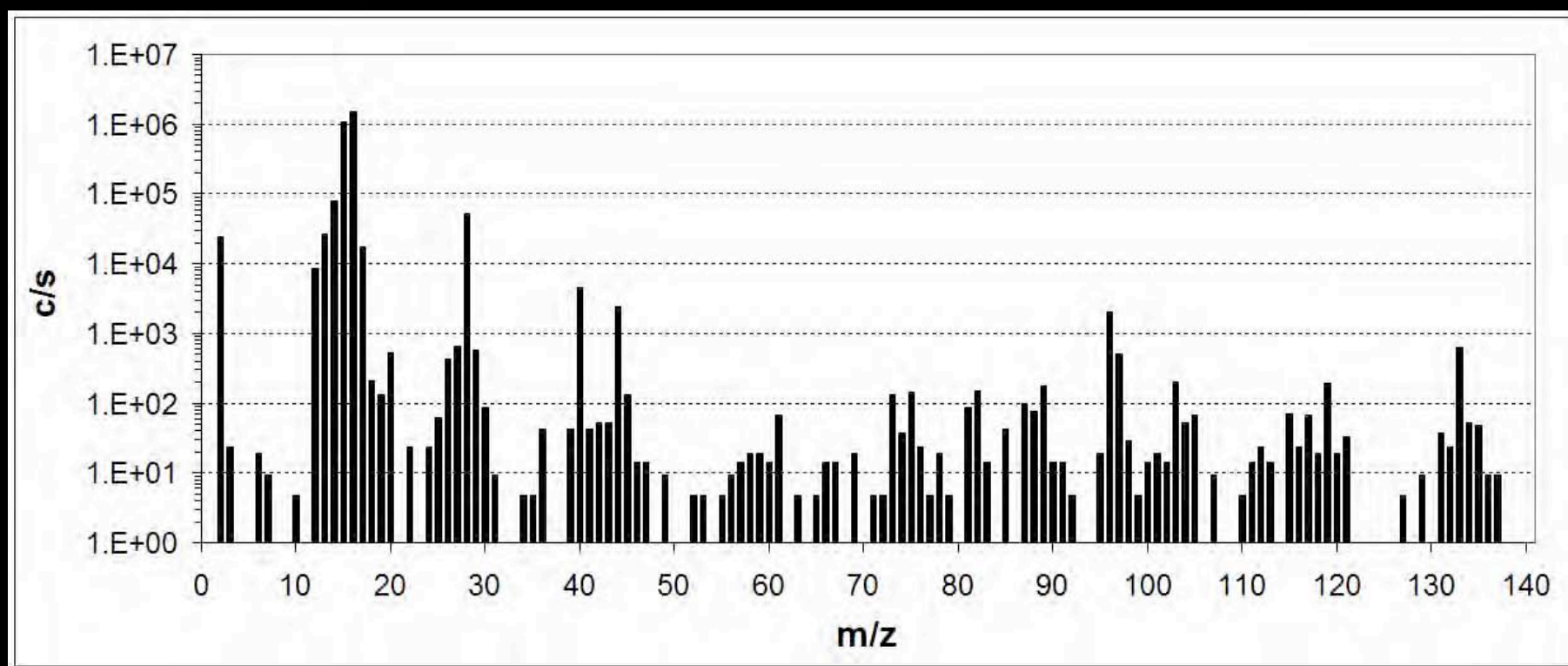


# Rare Gas Experiment Averaged Spectrum (with Background Subtracted)



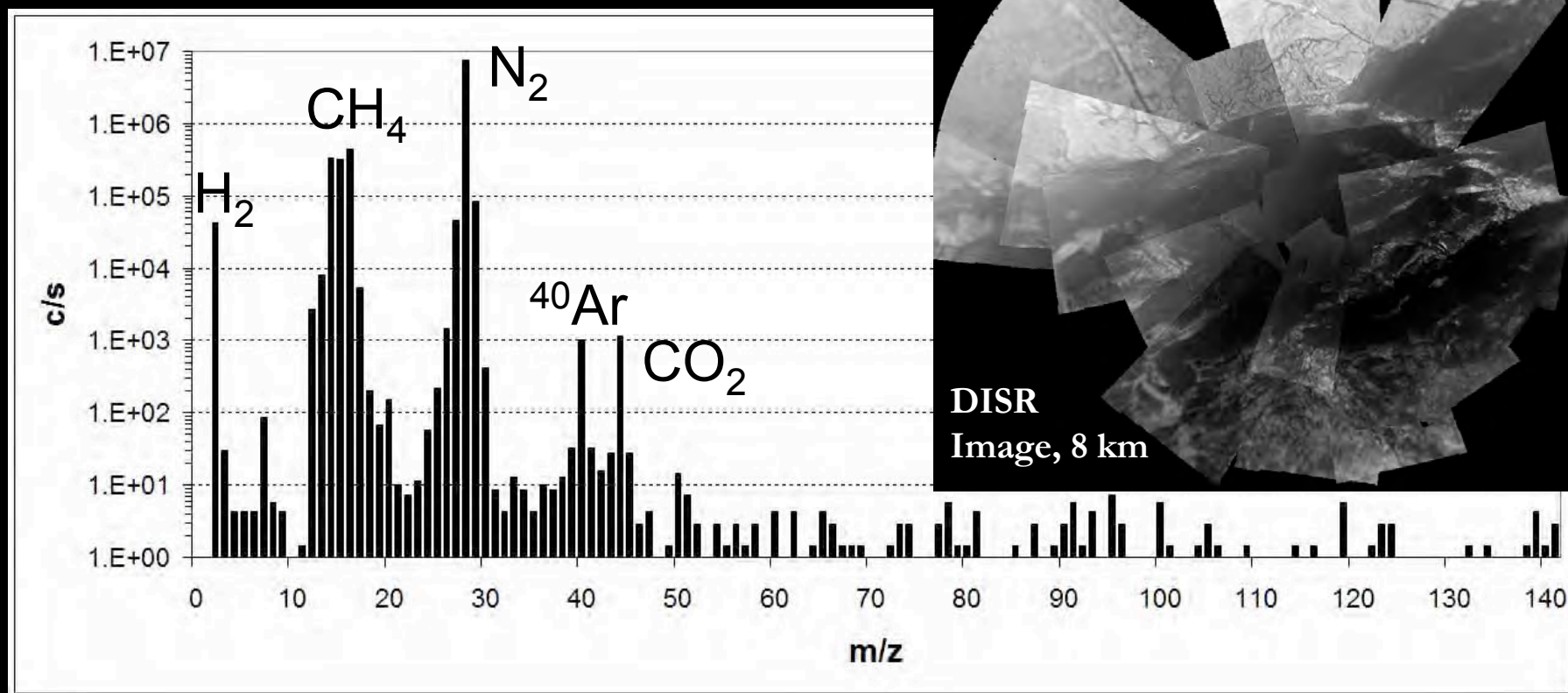


# Enrichment Cell Averaged Spectrum



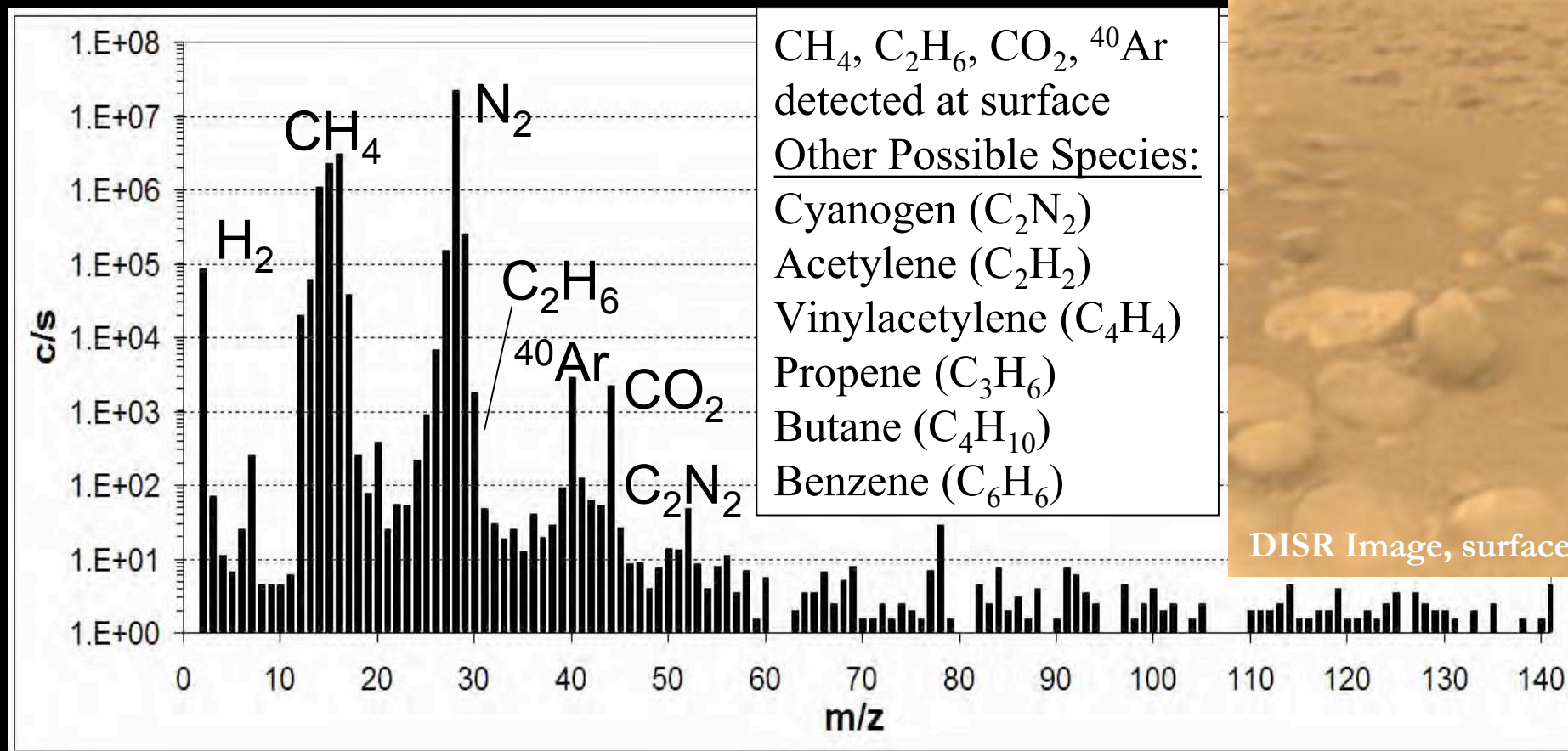


# Lower Atmosphere Averaged Spectrum (20-10 km)





# Averaged Surface Spectrum







# Isotope Ratios

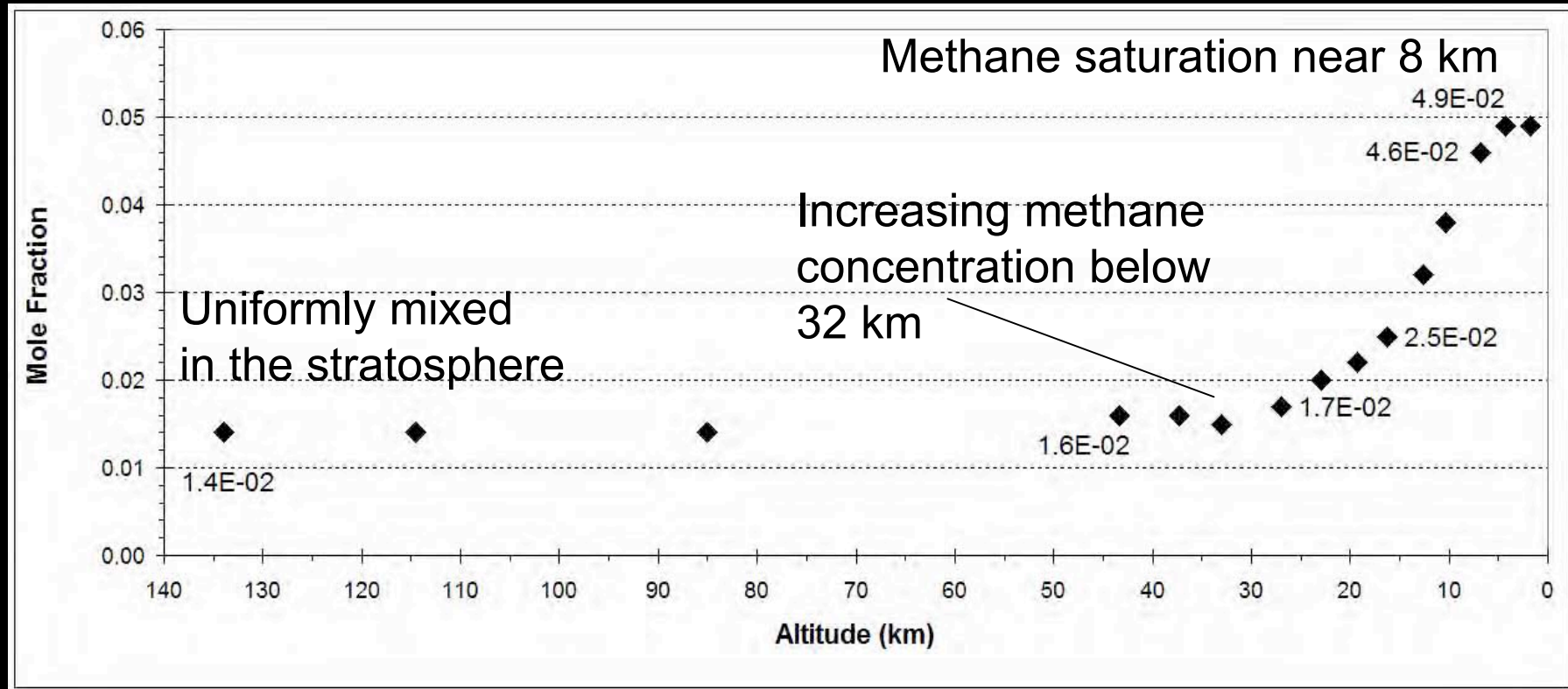
- $^{12}\text{C}/^{13}\text{C}$  and  $^{14}\text{N}/^{15}\text{N}$  in the atmosphere were determined from methane ( $^{12}\text{CH}_4$  and  $^{13}\text{CH}_4$  at  $m/z$  of 16 and 17) and nitrogen ( $^{14}\text{N}^{14}\text{N}$  and  $^{15}\text{N}^{14}\text{N}$  at  $m/z$  of 28 and 29)
- D/H was determined from  $\text{H}_2$  and HD
- Isotope ratios were calculated in altitude ranges with the best instrumental and statistical conditions
- Errors presented are due to signal statistics



Ratio	GCMS	Altitude for GCMS Calculations
$^{14}\text{N}/^{15}\text{N}$	$183 \pm 5$	40.9 km-35.9 km
$^{12}\text{C}/^{13}\text{C}$	$82.3 \pm 1$	18.2 km-6.14 km
D/H	$(2.1 \pm 0.04) \times 10^{-4}$	124.9 km- 66.8 km
$^{40}\text{Ar}/(\text{N}_2 + \text{CH}_4)$	$(4.32 \pm 0.1) \times 10^{-5}$	10 km to surface

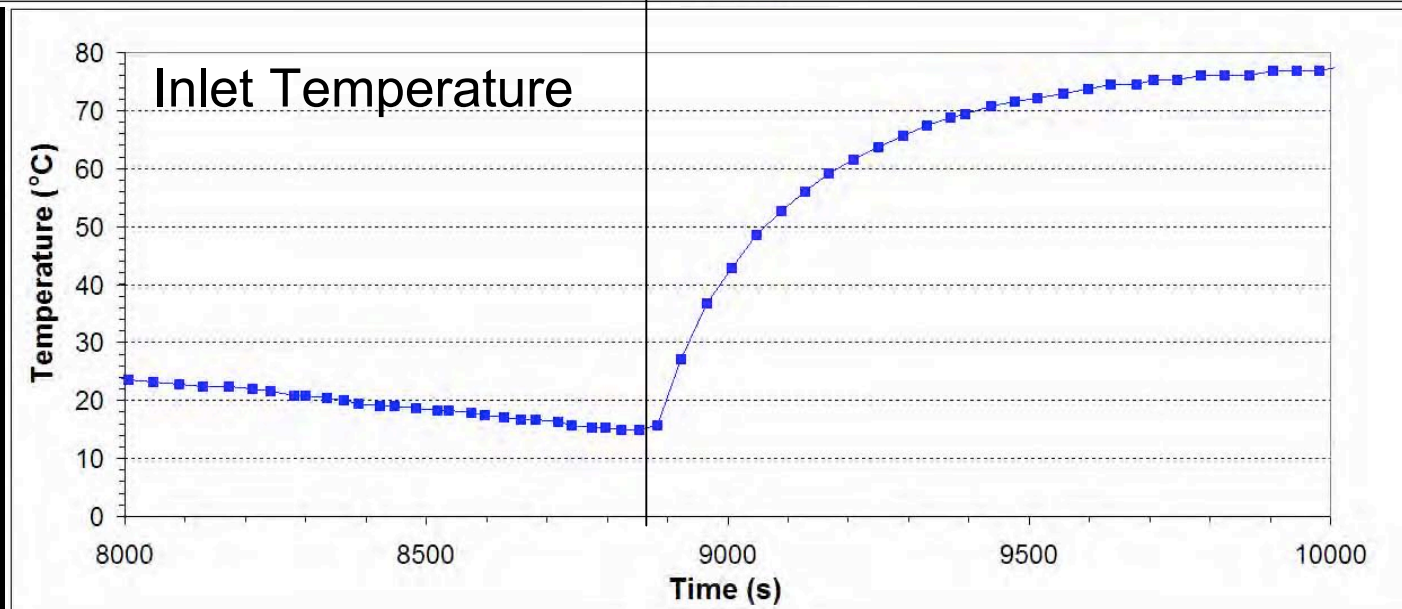
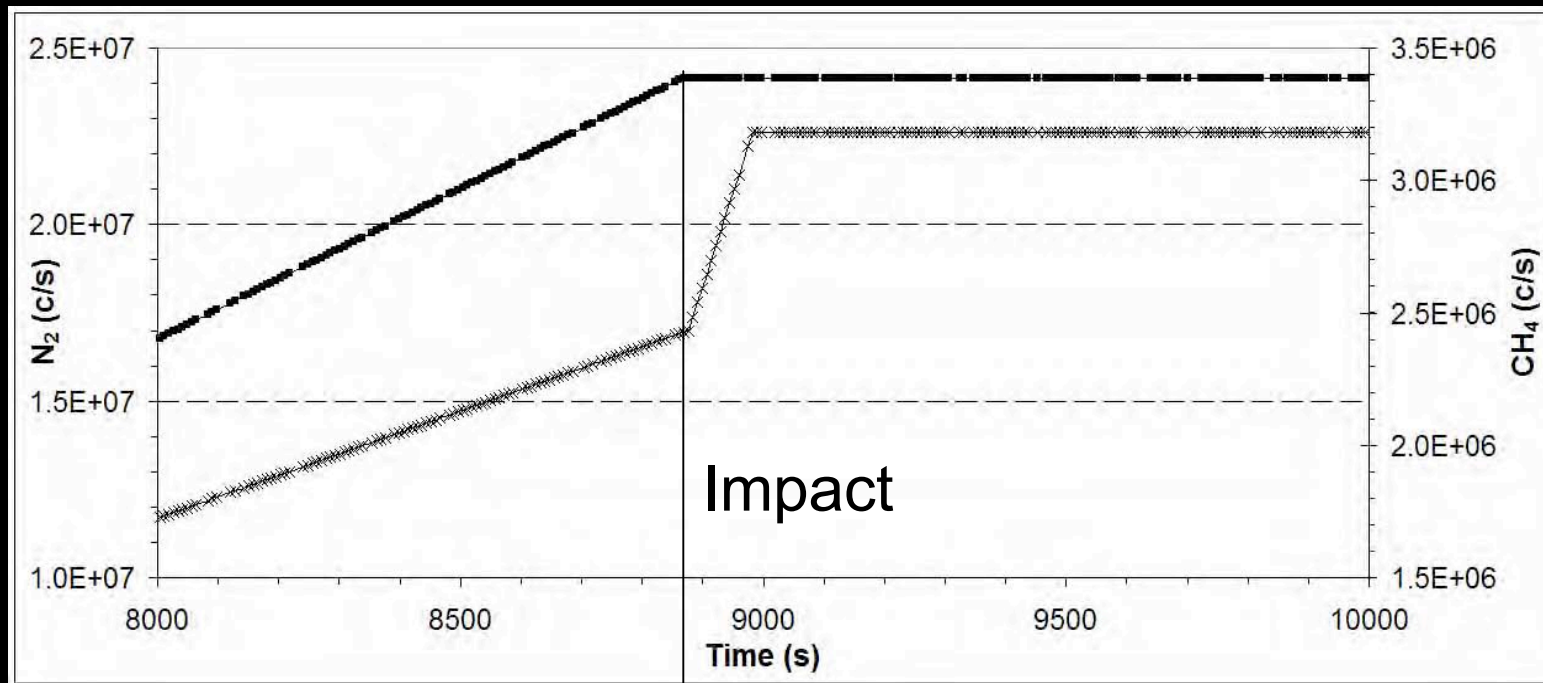


# Methane Mole Fraction Altitude Profile





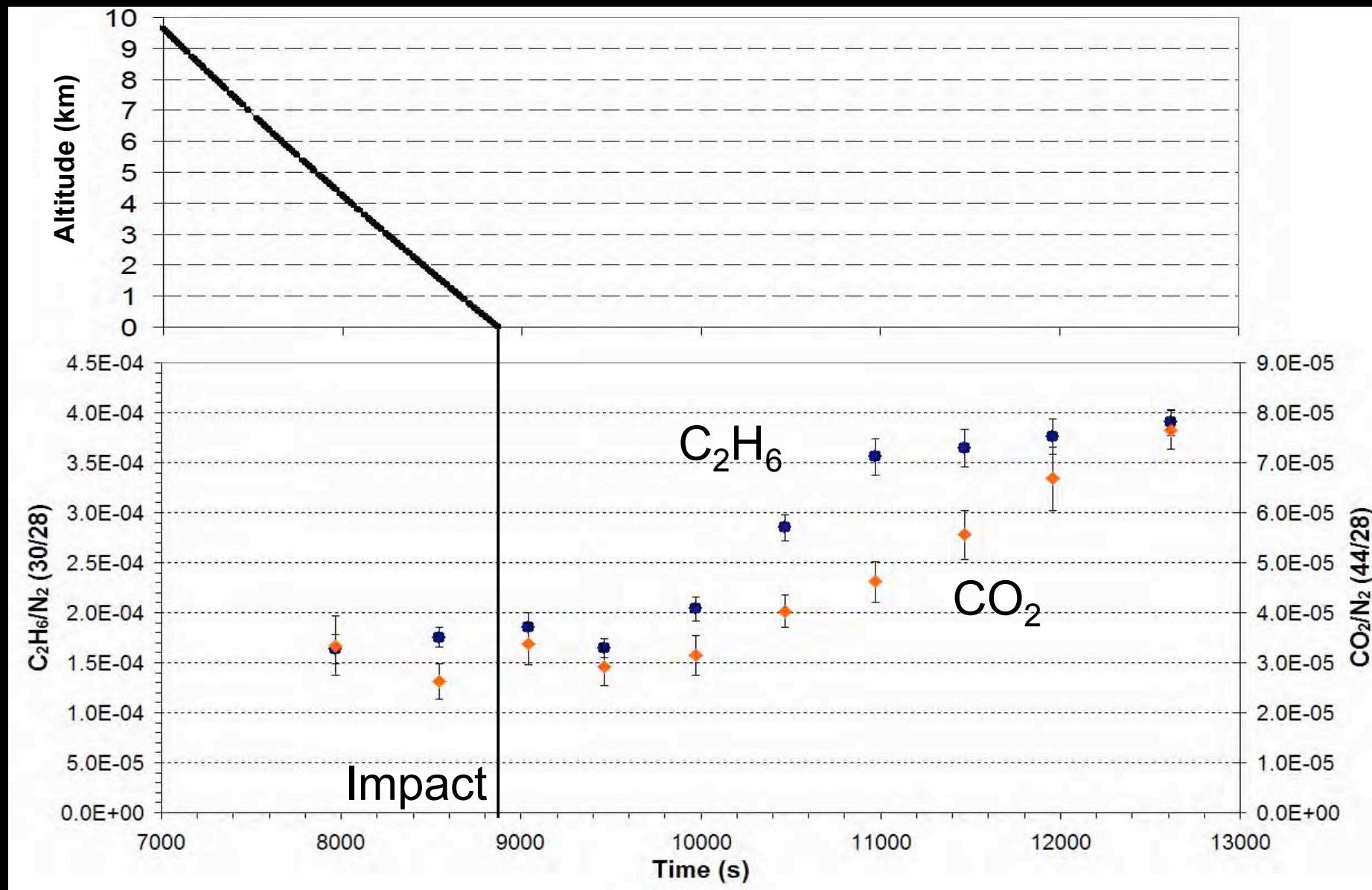
# Surface Response of $N_2$ and $CH_4$





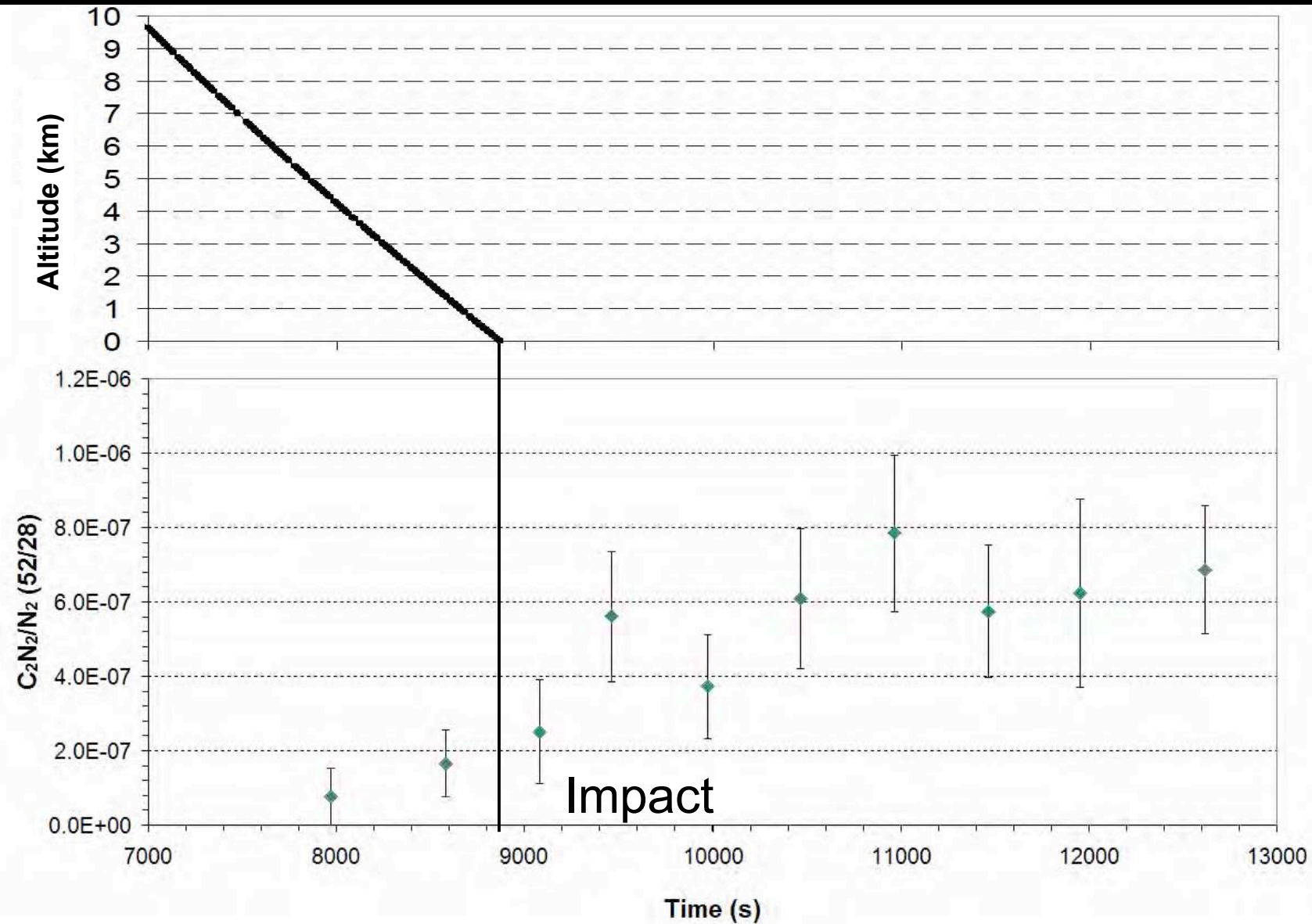


# Surface Response of $C_2H_6$ and $CO_2$





# Surface Response of Cyanogen ( $C_2N_2$ )





# Summary

- Increase in methane mole fraction near and at surface suggests a humid atmosphere and liquid methane in near sub-surface
- Primordial noble gases in low concentration- upper limit for  $^{36}\text{Ar}$  is  $3 \times 10^{-7}$ ; Kr, Xe is  $10^{-8}$
- As predicted, organic molecules were not detected in large quantities in the atmosphere
- Ethane, Carbon dioxide and Cyanogen detected on the surface
- Landed on organic rich surface



# Lessons Learned

- The mission design was appropriate
- In hindsight additional surface oriented measurements would have been useful, including ACP surface measurements